

Claims

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (currently amended) A liquid crystal display having a plurality of stacked layers comprising:

a plurality of layers of liquid crystal material each having opposing surfaces;

a plurality of electrically conductive layers disposed so as to be located near both of said opposing surfaces of said liquid crystal layers, wherein each pair of adjacent liquid crystal layers has exactly ~~only~~ one of said electrically conductive layers ~~is~~ disposed between said pair of adjacent said liquid crystal layers;[[,]] and

drive electronics adapted to apply ~~the same~~ voltage[[s]] pulses to each of said pair of adjacent ~~said~~ liquid crystal layers along the ~~only one said~~ electrically conductive layer provided between said pair of adjacent liquid crystal layers for driving both of said pair of adjacent liquid crystal layers.

2. (original) The liquid crystal display of claim 1 wherein said drive electronics includes one driver corresponding to each of said electrically conductive layers.

3. (original) The liquid crystal display of claim 2

wherein said driver comprises multiple drive chips.

4. (original) The liquid crystal display of claim 1 wherein said liquid crystal material comprises regions of liquid crystal dispersed in a polymer matrix.

5. (original) The liquid crystal display of claim 4 wherein said liquid crystal material comprises bistable cholesteric liquid crystal.

6. (original) The liquid crystal display of claim 1, wherein electrode lines of one of said electrically conductive layers are arranged perpendicular to electrode lines of an adjacent one of said electrically conductive layers.

7. (original) The liquid crystal display of claim 1, wherein said display is comprised of a plurality of pixels, with each pixel including a sub-pixel from each of said plurality of layers of liquid crystal material, wherein when a pixel is to be updated, the sub-pixels are addressed in sequence, such that while one sub-pixel is addressed to impose a brightness state change on that sub-pixel the remaining sub-pixels of that pixel are simultaneously addressed to maintain their current brightness state.

8. (original) The liquid crystal display of claim 1 comprising only a single substrate on which said layers of the display are supported.

9. (currently amended) A stacked liquid crystal display sequentially comprising the following stacked

layers:

- a top electrode layer of electrodes;
- a first liquid crystal layer;
- an upper middle electrode layer of electrodes;
- a second liquid crystal layer;
- a lower middle electrode layer of electrodes;
- a third liquid crystal layer;
- a bottom electrode layer of electrodes;[[,]] and
- a shared electrode addressing construction in which
 - said upper middle electrode layer is adapted to enable driving of said first liquid crystal layer and said second liquid crystal layer and said lower middle electrode layer is adapted to enable driving of said second liquid crystal layer and said third liquid crystal layer.

10. (original) The stacked liquid crystal display of claim 9, adapted such that a reflective state of a portion of said first liquid crystal layer corresponding to a pixel of said display is changed by providing a first non-zero voltage difference between an electrode of said top electrode layer and an electrode of said upper middle electrode layer.

11. (original) The stacked liquid crystal display of claim 10, adapted such that a reflective state of said portion of said first liquid crystal layer is maintained by providing a voltage difference less than a voltage threshold needed to change a reflective state of the liquid

crystal between said top electrode layer and said upper middle electrode layer.

12. (original) The stacked liquid crystal display of claim 10, adapted such that a reflective state of a portion of said second liquid crystal layer also corresponding to said pixel of said display is changed by providing a second non-zero voltage difference between an electrode of said upper middle electrode layer and an electrode of said lower middle electrode layer.

13. (original) The stacked liquid crystal display of claim 12, adapted such that a reflective state of a portion of said third liquid crystal layer also corresponding to said pixel of said display is changed by providing a third non-zero voltage difference between an electrode of said lower middle electrode layer and an electrode of said bottom electrode layer.

14. (original) The stacked liquid crystal display of claim 13, adapted such that said reflective states of said portions of said first, second and third liquid crystal layers all corresponding to said pixel of said display are updated sequentially in time to update a state of said pixel.

15. (original) The stacked liquid crystal display of claim 13, adapted such that the reflective states of two of said portions of said first, second and/or third liquid crystal layers each corresponding to said pixel of said display are updated concurrently in time to at least partially update a state of said pixel.

16. (original) The stacked liquid crystal display of claim 9, wherein said first liquid crystal layer, said second liquid crystal layer and said third liquid crystal layer comprise a dispersion of cholesteric liquid crystal in a polymer matrix.

17. (currently amended) ~~The stacked liquid crystal display of claim 9,~~ A stacked liquid crystal display sequentially comprising the following stacked layers:

a top electrode layer of electrodes; a first liquid crystal layer; an upper middle electrode layer of electrodes; a second liquid crystal layer;

a lower middle electrode layer of electrodes;

a third liquid crystal layer;

a bottom electrode layer of electrodes; and

a shared electrode addressing construction in which said upper middle electrode layer is adapted to enable driving of said first liquid crystal layer and said second liquid crystal layer and said lower middle electrode layer is adapted to enable driving of said second liquid crystal layer and said third liquid crystal layer, wherein

said display is adapted such that a reflective state of a portion said first liquid crystal layer corresponding to a pixel of said display is changed by providing a voltage difference between an electrode of said top electrode layer and an electrode of said upper middle electrode layer, and adapted such that a reflective state of a portion said second liquid crystal layer

corresponding to said pixel of said display is changed by providing a voltage difference between an electrode of said upper middle electrode layer and an electrode of said lower middle electrode layer, and further adapted such that a reflective state of a portion of said third liquid crystal layer corresponding to said pixel of said display is changed by providing a voltage difference between an electrode of said lower middle electrode layer and an electrode of said bottom electrode layer; thereby updating a state of said pixel of said display.

18. (original) The stacked liquid crystal display of claim 17 wherein a threshold voltage is needed to change a reflective state of the liquid crystal, said display being adapted such that a reflective state of said portion of said first liquid crystal layer is maintained by providing a voltage difference between said electrode of said top electrode layer and said electrode of said upper middle electrode layer below said threshold voltage, and adapted such that a reflective state of said portion of said second liquid crystal layer is maintained by providing a voltage difference between said electrode of said upper middle electrode layer and said electrode of said lower middle electrode layer below said threshold voltage, and further adapted such that a reflective state of said portion of said third liquid crystal layer is maintained by providing a voltage difference between said electrode of said lower middle electrode layer and said electrode of said bottom electrode layer below said threshold voltage.

19. (original) The stacked liquid crystal display of claim 18, further adapted such that the reflective states of two or more of said portions of said first, second, and third liquid crystal layers are updated sequentially in time.

20. (original) The stacked liquid crystal display of claim 18, further adapted such that the reflective states of two or more of said portions of said first, second, and third liquid crystal layers are updated concurrently in time.

21. (original) The stacked liquid crystal display of claim 18, further adapted such that the electrodes of one of said electrode layers are arranged perpendicular to the electrodes of an adjacent one of said electrode layers.

22. (currently amended) A stacked liquid crystal display comprising:

- a top electrode layer of electrodes;

- an upper middle electrode layer of electrodes;

- a first liquid crystal layer sandwiched between said top electrode layer and said upper middle electrode layer;

- a lower middle electrode layer of electrodes;

- a second liquid crystal layer sandwiched between said upper middle electrode layer and said lower middle electrode layer;

- a bottom electrode layer of electrodes; and

a third liquid crystal layer sandwiched between said lower middle electrode layer and said bottom electrode layer, wherein

a pixel of said display includes a portion of said first liquid crystal layer adapted to be addressed by the combination of an electrode of said top electrode layer and an electrode of said upper middle electrode layer, and wherein

said pixel of said display further includes a portion of said second liquid crystal layer adapted to be addressed by the combination of an electrode of said upper middle electrode layer and an electrode of said lower middle electrode layer, and further wherein

said pixel of said display further includes a portion of said third liquid crystal layer adapted to be addressed by the combination of an electrode of said lower middle electrode layer and an electrode of said bottom electrode layer.

23. (original) The stacked liquid crystal display of claim 22, further adapted such that a brightness state of said pixel is updated by addressing said portions of said liquid crystal layers in sequence.

24. (currently amended) A stacked liquid crystal display comprising:

a top electrode layer of electrodes;

an upper middle electrode layer of electrodes;

a first liquid crystal layer sandwiched between said top electrode layer and said upper middle electrode layer, adapted such that a brightness state of a portion said first liquid crystal layer corresponding to a pixel of said display is changed by providing a non-zero voltage difference between an electrode of said top electrode layer and an electrode of said upper middle electrode layer, and adapted such that a brightness state of said portion of said first liquid crystal layer is maintained by providing substantially no voltage difference between said electrode of said top electrode layer and said electrode of said upper middle electrode layer;

a lower middle electrode layer of electrodes;

a second liquid crystal layer sandwiched between said upper middle electrode layer and said lower middle electrode layer, adapted such that a brightness state of a portion said second liquid crystal layer corresponding to said pixel of said display is changed by providing a non-zero voltage difference between an electrode of said upper middle electrode layer and an electrode of said lower middle electrode layer, and adapted such that a brightness state of said portion of said second liquid crystal layer is maintained by providing substantially no voltage difference between said electrode of said upper middle electrode layer and said electrode of said lower middle electrode layer;

a bottom electrode layer of electrodes; and

a third liquid crystal layer sandwiched between said lower middle electrode layer and said bottom electrode layer, adapted such that a brightness state of a portion of said third liquid crystal layer corresponding to said pixel of said display is changed by providing a non-zero voltage difference between an electrode of said lower middle electrode layer and an electrode of said bottom electrode layer, and adapted such that a brightness state of said portion of said third liquid crystal layer is maintained by providing substantially no voltage difference between said electrode of said lower middle electrode layer and said electrode of said bottom electrode layer, wherein

said pixel is formed by a stacked arrangement of said portions of said first, second, and third liquid crystal layers such that a color of said pixel is formed by light reflecting from all of said portions of said first, second, and third liquid crystal layers, and further wherein

a brightness state of said pixel of said display is updated by changing and/or maintaining the brightness states of said portions of said first, second, and third liquid crystal layers sequentially or concurrently.

25. (original) The stacked liquid crystal display of claim 24, wherein one or more of said first, second, and third liquid crystal layers include bistable cholesteric liquid crystal material.

26. (currently amended) A multi-layer stacked liquid crystal display film comprising:

- a plurality of liquid crystal film layers; and
- a plurality of electrode film layers for driving said plurality of liquid crystal [[F]]film layers, wherein

- all of said film layers are printed or coated in a stack upon each other, wherein

- a pixel is formed from a portion of each of said plurality of liquid crystal layers, such that a color or shade of said pixel is formed by light reflecting from all of said portions of said plurality of liquid crystal layers, and wherein

- at least one of said plurality of electrode layers is adapted to enable driving of two adjacent said liquid crystal layers.

27. (original) The stacked liquid crystal display film of claim 26, wherein each of said portions of said plurality of electrode layers is driven sequentially in time to change or maintain said color of said pixel.

28. (original) A stacked liquid crystal display comprising a base substrate and a plurality of film layers printed or coated onto each other in a stack and supported on said substrate, said film layers comprising:

- a plurality of conducting film layers; and
- a plurality of liquid crystal dispersion film layers each comprising regions of liquid crystal material dispersed in a polymer matrix, said

liquid crystal dispersion layers being separated by said conducting layers, wherein

at least one of said plurality of conducting layers is adapted to enable driving of two adjacent said liquid crystal dispersion layers.

29. (original) The display of claim 28 comprising flexible interconnects extending from each of said conducting film layers at a side of said display to conductors located on said substrate at the same side of said display.

30. (original) The display of claim 28 wherein said plurality of liquid crystal dispersion layers includes at least three liquid crystal dispersion layers including bistable cholesteric liquid crystal material.

31. (original) The display of claim 28 wherein said plurality of liquid crystal dispersion layers includes at least six liquid crystal dispersion layers including bistable cholesteric liquid crystal material.

32. (original) A liquid crystal display comprising:

a first liquid crystal layer comprising liquid crystal that is bistable in an absence of an electric field;

a second liquid crystal layer comprising liquid crystal that is bistable in an absence of an electric field stacked upon said first liquid crystal layer, wherein said liquid crystal is a dispersion of liquid crystal in a polymer matrix;

a first electrode layer disposed between said first liquid crystal layer and said second liquid crystal layer;

a second electrode layer disposed between said first liquid crystal layer and said second liquid crystal layer;

electrical interconnects that electrically connect said first electrode layer and said second electrode layer together in parallel; and

drive electronics electrically connected to said electrical interconnects adapted to address both of said first liquid crystal layer and said second liquid crystal layer with the same voltage pulses.

33. (original) The liquid crystal display of claim 32, wherein said liquid crystal layers reflect visible and infrared light.

34. (original) A liquid crystal display comprising:

a first liquid crystal layer comprising liquid crystal that is bistable in an absence of an electric field;

a second liquid crystal layer comprising liquid crystal that is bistable in an absence of an electric field stacked upon said first liquid crystal layer, wherein said first liquid crystal layer and said second liquid crystal layer comprise a dispersion of bistable cholesteric liquid crystal material in a polymer matrix;

only a single electrode layer disposed between said first liquid crystal layer and said second liquid crystal layer; and

drive electronics electrically connected to said single electrode layer adapted to address both said first liquid crystal layer and said second liquid crystal layer with the same voltage pulses.

35. (new) The liquid crystal display of claim 1, wherein one of said electrically conductive layers is arranged on top of said stacked layers, and wherein another of said electrically conductive layers is arranged on bottom of said staked layers.

36. (new) The liquid crystal display of claim 1, wherein said voltage pulses applied to adjacent liquid crystal layers are provided such that a portion of one of said layers is being addressed for an update, wherein a portion of the other of said liquid crystal layers is simultaneously being addressed to maintain its current state.

37. (new) The liquid crystal display of claim 1, wherein each conductive layer includes electrodes that are arranged perpendicular to any adjacent conductive layer(s).

38. (new) The stacked liquid crystal display of claim 22, wherein said electrodes of said upper middle electrode layer are arranged perpendicular to the electrodes of said top electrode layer and said lower middle electrode layer, and where said electrodes of said lower middle electrode

layer are arranged perpendicular to the electrodes of said bottom electrode layer.

39. (new) The stacked liquid crystal display of claim 24, wherein said electrodes of said upper middle electrode layer are arranged perpendicular to the electrodes of said top electrode layer and said lower middle electrode layer, and where said electrodes of said lower middle electrode layer are arranged perpendicular to the electrodes of said bottom electrode layer.

40. (new) The stacked liquid crystal display of claim 24, wherein said electrodes of said upper middle electrode layer are arranged perpendicular to the electrodes of said top electrode layer and said lower middle electrode layer, and where said electrodes of said lower middle electrode layer are arranged perpendicular to the electrodes of said bottom electrode layer.

41. (new) The liquid crystal display of claim 32, wherein when said voltage pulses are applied to first and second liquid crystal layers, a portion of one of said liquid crystal layers is being addressed for a state update whereas a corresponding portion of the other of said liquid crystal layers is simultaneously being addressed to maintain its current state.

42. (new) The liquid crystal display of claim 34, wherein said voltage pulses applied by said single electrode layer to said first and second liquid crystal layers such that a portion of one of said layers is being addressed for an update while simultaneously a portion of

the other of said liquid crystal layers being addressed to maintain its current state.

43. (new) A liquid crystal display having a plurality of stacked layers comprising:

a plurality of layers of liquid crystal material; and

a plurality of layers of electrodes such that each of said plurality of layers of liquid crystal material is adjacent to exactly two of said plurality of layers of electrodes, wherein

each one of said electrode layers provided between and adjacent to two layers of liquid crystal material is used to drive each one of said adjacent layers of liquid crystal material.

44. (new) The liquid crystal display of claim 43, wherein each one of said electrode layers provided between and adjacent to two layers of liquid crystal material is used to drive each one of said adjacent layers such that said layers of layers of liquid crystal material are driven sequentially.

45. (new) The liquid crystal display of claim 43, wherein each one of said electrode layers provided between and adjacent to two layers of liquid crystal material is utilized to provide a 'select' to one of said layers of liquid crystal material and simultaneously provide a 'non-select' waveform to another of said layers of liquid crystal material.

46. (new) A liquid crystal display having a plurality

of stacked layers comprising:

- a plurality of layers of liquid crystal material; and
- a plurality of layers of electrodes such that each of said plurality of layers of liquid crystal material is adjacent to exactly two of said plurality of layers of electrodes, wherein each one of said pixel is comprised of plurality of sub-pixels, wherein each one of said sub-pixels is provided by one of said layers of liquid crystal material, and wherein each pixel is driven by selectively driving, in sequence, each one of its corresponding sub-pixels one at a time while simultaneously deselecting the others of its sub-pixels.

47. (new) A liquid crystal display having a plurality of stacked layers comprising:

- a plurality of layers of liquid crystal material each having opposing surfaces and arranged in a stack;
- a plurality of electrically conductive layers arranged such that one of said electrically conductive layers is at the top of the stack, one of said electrically conductive layers is arranged at the bottom of the stack, and each one of the remainder of said electrically conductive layers is arranged between a different adjacent pair of said layers of liquid crystal material; and
- drive electronics adapted to drive said display such that each one of said electrically conductive layers that is arranged between a different

adjacent pair of said layers of liquid crystal material is utilized to drive both layers of said adjacent pair of layers of liquid crystal material.

48. (new) The liquid crystal display of claim 47, wherein each one of said electrically conductive layers provided between and adjacent to two layers of liquid crystal material is utilized to provide a 'select' to one of said layers of liquid crystal material and simultaneously provide a 'non-select' waveform to another of said layers of liquid crystal material.